Clustering

# Clustering

## BAN502

### Danielle Harris

library(tidyverse)

## ── Attaching packages ────────────────────────────────────────── tidyverse 1.2.1 ──

## ✔ ggplot2 3.1.0 ✔ purrr 0.3.0   
## ✔ tibble 2.0.1 ✔ dplyr 0.8.0.1  
## ✔ tidyr 0.8.2 ✔ stringr 1.4.0   
## ✔ readr 1.3.1 ✔ forcats 0.4.0

## Warning: package 'tibble' was built under R version 3.5.2

## Warning: package 'purrr' was built under R version 3.5.2

## Warning: package 'dplyr' was built under R version 3.5.2

## Warning: package 'stringr' was built under R version 3.5.2

## Warning: package 'forcats' was built under R version 3.5.2

## ── Conflicts ───────────────────────────────────────────── tidyverse\_conflicts() ──  
## ✖ dplyr::filter() masks stats::filter()  
## ✖ dplyr::lag() masks stats::lag()

library(cluster)  
library(factoextra)

## Welcome! Related Books: `Practical Guide To Cluster Analysis in R` at https://goo.gl/13EFCZ

# Read in data

trucks = read\_csv("trucks.csv")

## Parsed with column specification:  
## cols(  
## Driver\_ID = col\_double(),  
## Distance = col\_double(),  
## Speeding = col\_double()  
## )

str(trucks)

## Classes 'spec\_tbl\_df', 'tbl\_df', 'tbl' and 'data.frame': 4000 obs. of 3 variables:  
## $ Driver\_ID: num 3.42e+09 3.42e+09 3.42e+09 3.42e+09 3.42e+09 ...  
## $ Distance : num 71.2 52.5 64.5 55.7 54.6 ...  
## $ Speeding : num 28 25 27 22 25 10 20 8 34 19 ...  
## - attr(\*, "spec")=  
## .. cols(  
## .. Driver\_ID = col\_double(),  
## .. Distance = col\_double(),  
## .. Speeding = col\_double()  
## .. )

summary(trucks)

## Driver\_ID Distance Speeding   
## Min. :3.423e+09 Min. : 15.52 Min. : 0.00   
## 1st Qu.:3.423e+09 1st Qu.: 45.25 1st Qu.: 4.00   
## Median :3.423e+09 Median : 53.33 Median : 6.00   
## Mean :3.423e+09 Mean : 76.04 Mean : 10.72   
## 3rd Qu.:3.423e+09 3rd Qu.: 65.63 3rd Qu.: 9.00   
## Max. :3.423e+09 Max. :244.79 Max. :100.00

# Task1

trucks1 = trucks %>% select("Distance","Speeding")  
str(trucks1)

## Classes 'spec\_tbl\_df', 'tbl\_df', 'tbl' and 'data.frame': 4000 obs. of 2 variables:  
## $ Distance: num 71.2 52.5 64.5 55.7 54.6 ...  
## $ Speeding: num 28 25 27 22 25 10 20 8 34 19 ...  
## - attr(\*, "spec")=  
## .. cols(  
## .. Driver\_ID = col\_double(),  
## .. Distance = col\_double(),  
## .. Speeding = col\_double()  
## .. )

set.seed(1234)  
clusters1 <- kmeans(trucks1, 2)  
clusters1

## K-means clustering with 2 clusters of sizes 800, 3200  
##   
## Cluster means:  
## Distance Speeding  
## 1 180.01707 18.29000  
## 2 50.04763 8.82875  
##   
## Clustering vector:  
## [1] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [35] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [69] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [103] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [137] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [171] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [205] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [239] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [273] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [307] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [341] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [375] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [409] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [443] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [477] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [511] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [545] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [613] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [647] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [715] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [749] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [783] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [817] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [851] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [885] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [919] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [953] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [987] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1021] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1055] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1089] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1123] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1157] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1191] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1225] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1259] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [1361] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1395] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1429] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1463] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1497] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1531] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1565] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1599] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [1667] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [1735] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1769] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1803] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1837] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1871] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1905] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1939] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1973] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [2007] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [2041] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [2075] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [2551] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [2585] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [2755] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [2789] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [2823] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [2857] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [2891] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [2925] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [2959] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [2993] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [3027] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [3129] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [3163] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [3197] 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3231] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3265] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3299] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3333] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3367] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3401] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3435] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3469] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3503] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3537] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3571] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3605] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3639] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3673] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3707] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3741] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
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## [3843] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3877] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3911] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3945] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3979] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
##   
## Within cluster sum of squares by cluster:  
## [1] 668369.7 648051.1  
## (between\_SS / total\_SS = 89.2 %)  
##   
## Available components:  
##   
## [1] "cluster" "centers" "totss" "withinss"   
## [5] "tot.withinss" "betweenss" "size" "iter"   
## [9] "ifault"

fviz\_cluster(clusters1, trucks1)

 ##There appears to be clustering of speeding and clustering of distance, but the Cluster plot does not display a significant realtionship between the two variables.

# Task2

## Create a new data frame

trucks2 = scale(trucks1)  
as.data.frame(trucks2)

## Distance Speeding  
## 1 -0.089799173 1.26045492  
## 2 -0.439717876 1.04161328  
## 3 -0.215104107 1.18750771  
## 4 -0.380618833 0.82277163  
## 5 -0.401378307 1.04161328  
## 6 -0.638335547 -0.05259494  
## 7 -0.325447258 0.67687721  
## 8 -0.449256013 -0.19848937  
## 9 -0.837701308 1.69813821  
## 10 -0.593450198 0.60392999  
## 11 -0.499190964 2.13582150  
## 12 -0.336107528 2.50055757  
## 13 -0.595133399 0.82277163  
## 14 -0.379870744 0.60392999  
## 15 -0.550061027 2.35466314  
## 16 -0.431488896 1.55224378  
## 17 -0.557167874 1.77108543  
## 18 -0.458046061 1.18750771  
## 19 -0.355183802 1.11456049  
## 20 -0.329000681 1.40634935  
## 21 -0.610095182 0.89571885  
## 22 -0.380805855 1.91697986  
## 23 -0.390718036 0.53098278  
## 24 -0.602240246 0.82277163  
## 25 -0.313851876 1.55224378  
## 26 -0.727545179 2.20876871  
## 27 -0.219592642 1.33340214  
## 28 -0.566518988 0.38508835  
## 29 -0.562404498 0.89571885  
## 30 -0.374073053 2.06287428  
## 31 -0.793002981 2.50055757  
## 32 -0.642824082 1.62519100  
## 33 -0.474317000 2.06287428  
## 34 -0.408111109 1.77108543  
## 35 -0.371080696 1.33340214  
## 36 -0.558851075 2.20876871  
## 37 -0.482920025 0.96866606  
## 38 -0.493393273 1.62519100  
## 39 -0.700052903 1.91697986  
## 40 -0.388286747 1.84403264  
## 41 -0.339847974 2.20876871  
## 42 -0.268405459 0.09329949  
## 43 -0.722495578 0.74982442  
## 44 -0.415404979 1.55224378  
## 45 -0.244279584 0.82277163  
## 46 -0.543702269 0.16624670  
## 47 -0.336855617 0.96866606  
## 48 -0.302443516 1.84403264  
## 49 0.099093339 1.47929657  
## 50 -0.513965725 1.11456049  
## 51 -1.091864599 0.89571885  
## 52 -0.561656409 0.74982442  
## 53 -0.574186902 1.11456049  
## 54 -0.680789607 1.47929657  
## 55 -0.464217796 1.84403264  
## 56 -0.744938252 1.47929657  
## 57 -0.537156489 3.23002972  
## 58 -0.395954661 1.18750771  
## 59 -0.319275522 -0.34438380  
## 60 -0.350508244 2.28171593  
## 61 -0.301134360 1.55224378  
## 62 -0.267844392 1.04161328  
## 63 -0.427374405 0.89571885  
## 64 -0.765136660 1.98992707  
## 65 -0.515648926 0.67687721  
## 66 -0.465152908 2.35466314  
## 67 -0.634034035 2.06287428  
## 68 -0.406427909 1.77108543  
## 69 -0.507045900 1.55224378  
## 70 -0.421389692 2.42761036  
## 71 -0.454866682 0.96866606  
## 72 -0.489652828 -0.05259494  
## 73 -0.501996299 2.20876871  
## 74 -0.296271780 2.06287428  
## 75 -0.411103466 0.67687721  
## 76 -0.058566451 1.40634935  
## 77 -0.264103947 2.13582150  
## 78 -0.595507443 0.96866606  
## 79 -0.285985554 2.06287428  
## 80 -0.143661592 1.91697986  
## 81 -0.367527273 0.67687721  
## 82 -0.707907839 0.31214113  
## 83 -0.184245429 1.18750771  
## 84 -0.333676238 0.45803556  
## 85 -0.532854976 0.82277163  
## 86 -0.718568110 0.38508835  
## 87 -1.089059265 1.11456049  
## 88 -0.837701308 1.33340214  
## 89 -0.281309997 2.20876871  
## 90 -0.655728620 1.62519100  
## 91 -0.418023291 0.96866606  
## 92 -0.459729261 -0.12554216  
## 93 -0.214543040 1.33340214  
## 94 -0.416153068 0.89571885  
## 95 -0.219966686 1.69813821  
## 96 -0.703793349 0.96866606  
## 97 -0.320771700 2.28171593  
## 98 -0.596068510 1.62519100  
## 99 -0.479366602 2.35466314  
## 100 -0.232123135 1.26045492  
## 101 -0.565957922 0.96866606  
## 102 -0.382115011 0.67687721  
## 103 -0.164795111 -0.41733102  
## 104 -0.492832206 1.98992707  
## 105 -0.401004262 1.40634935  
## 106 -0.656476710 3.52181858  
## 107 -0.602240246 1.84403264  
## 108 -0.368088339 0.60392999  
## 109 -0.121779984 0.89571885  
## 110 -0.459355217 0.60392999  
## 111 -0.432236985 2.20876871  
## 112 -0.383798212 -0.19848937  
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## 3602 1.979602458 0.45803556  
## 3603 1.810534308 0.16624670  
## 3604 3.155972658 -0.12554216  
## 3605 1.884221090 -0.19848937  
## 3606 1.354012900 -0.27143659  
## 3607 2.629878958 -0.12554216  
## 3608 1.591531208 -0.05259494  
## 3609 2.007468779 -0.56322544  
## 3610 1.856167747 0.02035227  
## 3611 1.701500314 -0.05259494  
## 3612 2.955858808 -0.27143659  
## 3613 1.738156683 0.23919392  
## 3614 3.110713264 0.31214113  
## 3615 1.584798405 0.02035227  
## 3616 2.141750783 0.02035227  
## 3617 2.230960415 0.23919392  
## 3618 2.247792421 -0.49027823  
## 3619 2.500833578 0.31214113  
## 3620 1.809225152 -0.41733102  
## 3621 2.355517259 0.31214113  
## 3622 1.618088373 0.16624670  
## 3623 2.165128569 -0.27143659  
## 3624 1.770698561 -0.70911987  
## 3625 2.120991309 0.74982442  
## 3626 2.126976022 0.38508835  
## 3627 2.349906591 0.23919392  
## 3628 2.161014079 0.09329949  
## 3629 1.475390366 0.23919392  
## 3630 1.368039572 0.38508835  
## 3631 1.665030967 0.09329949  
## 3632 1.506062021 -0.27143659  
## 3633 1.613973882 -0.12554216  
## 3634 1.903484386 0.09329949  
## 3635 2.413120125 0.31214113  
## 3636 1.492222372 -0.05259494  
## 3637 1.972869656 0.16624670  
## 3638 2.241059618 -0.56322544  
## 3639 1.762843625 -0.34438380  
## 3640 1.717771253 0.31214113  
## 3641 2.078350227 -0.27143659  
## 3642 1.454443870 0.53098278  
## 3643 1.654931764 -0.27143659  
## 3644 1.847190677 0.16624670  
## 3645 1.422463058 -0.05259494  
## 3646 1.518966559 0.53098278  
## 3647 2.374967578 -0.05259494  
## 3648 1.809225152 -0.19848937  
## 3649 1.662786700 0.02035227  
## 3650 2.000174910 -0.41733102  
## 3651 1.774064962 -0.78206709  
## 3652 1.393848648 0.31214113  
## 3653 2.083586851 -0.49027823  
## 3654 1.120983128 0.23919392  
## 3655 2.085457074 -0.41733102  
## 3656 3.098369793 0.82277163  
## 3657 1.720576587 0.09329949  
## 3658 1.495588773 0.23919392  
## 3659 2.126601977 -0.12554216  
## 3660 1.914705724 -0.56322544  
## 3661 2.528886922 -0.34438380  
## 3662 1.789026745 0.09329949  
## 3663 1.290986389 -0.34438380  
## 3664 2.216372676 -0.34438380  
## 3665 1.518966559 -0.05259494  
## 3666 1.445653822 -0.12554216  
## 3667 2.201971960 -0.34438380  
## 3668 2.331765429 0.67687721  
## 3669 2.191311689 0.23919392  
## 3670 1.873747842 0.38508835  
## 3671 1.796694659 0.09329949  
## 3672 2.193181912 -0.19848937  
## 3673 1.837652540 0.09329949  
## 3674 1.652500474 -0.05259494  
## 3675 1.620332640 -0.41733102  
## 3676 1.823625869 -0.56322544  
## 3677 1.797442748 -0.19848937  
## 3678 2.371414154 0.45803556  
## 3679 2.279960255 -0.05259494  
## 3680 1.705053737 -0.41733102  
## 3681 1.131082331 0.16624670  
## 3682 2.316803646 -0.78206709  
## 3683 1.422276036 0.96866606  
## 3684 1.773503895 0.31214113  
## 3685 1.143051758 0.38508835  
## 3686 1.652126429 -0.19848937  
## 3687 2.550394485 0.09329949  
## 3688 1.633050156 0.31214113  
## 3689 1.538603900 -0.49027823  
## 3690 1.612477704 0.23919392  
## 3691 2.542539549 -0.34438380  
## 3692 1.575073246 0.67687721  
## 3693 2.859916374 0.16624670  
## 3694 1.994564241 0.02035227  
## 3695 1.622576908 0.02035227  
## 3696 2.198231514 0.38508835  
## 3697 1.593775475 -0.05259494  
## 3698 2.339246320 0.60392999  
## 3699 1.969503254 0.16624670  
## 3700 1.731797925 -0.12554216  
## 3701 1.861591393 -0.12554216  
## 3702 1.573951113 -0.12554216  
## 3703 2.172796483 -0.34438380  
## 3704 2.273414474 -0.05259494  
## 3705 2.127911133 -0.27143659  
## 3706 2.426772752 0.16624670  
## 3707 2.193555957 0.09329949  
## 3708 1.047109324 0.31214113  
## 3709 2.137449270 0.23919392  
## 3710 1.830171649 0.02035227  
## 3711 1.927610262 -0.34438380  
## 3712 2.498589311 -0.27143659  
## 3713 1.605744902 0.31214113  
## 3714 1.694019422 -0.12554216  
## 3715 1.600882322 -0.05259494  
## 3716 1.624447131 -0.05259494  
## 3717 1.923308749 -0.05259494  
## 3718 1.794076347 0.09329949  
## 3719 1.936026265 0.45803556  
## 3720 2.104907392 0.38508835  
## 3721 1.403573807 0.16624670  
## 3722 2.222357389 -0.19848937  
## 3723 2.322227292 -0.41733102  
## 3724 2.250784777 -0.34438380  
## 3725 2.188319333 0.02035227  
## 3726 2.011770292 -0.34438380  
## 3727 1.697385823 -0.19848937  
## 3728 2.139693538 0.23919392  
## 3729 2.024487807 -0.27143659  
## 3730 2.270422118 0.31214113  
## 3731 1.770698561 -0.27143659  
## 3732 1.730301746 -0.41733102  
## 3733 1.723942989 -0.12554216  
## 3734 1.667836302 0.38508835  
## 3735 1.259192600 -0.05259494  
## 3736 2.771641853 0.38508835  
## 3737 1.822503735 -0.19848937  
## 3738 2.132025624 0.38508835  
## 3739 1.914144657 0.02035227  
## 3740 2.218803966 -0.63617266  
## 3741 1.770698561 -0.70911987  
## 3742 1.974926901 0.45803556  
## 3743 2.455574184 -0.12554216  
## 3744 2.128472200 -0.12554216  
## 3745 1.249093396 -0.41733102  
## 3746 1.722446810 -0.70911987  
## 3747 1.606492991 -0.12554216  
## 3748 1.414047055 -0.70911987  
## 3749 1.893572205 -0.05259494  
## 3750 1.813713687 -0.56322544  
## 3751 1.992881041 -0.05259494  
## 3752 2.482505394 0.02035227  
## 3753 1.579561781 0.23919392  
## 3754 1.765648959 -0.70911987  
## 3755 1.651939407 -0.27143659  
## 3756 1.946125468 0.23919392  
## 3757 2.174479683 0.09329949  
## 3758 1.717584231 -0.34438380  
## 3759 2.908729191 0.16624670  
## 3760 2.125292821 -0.05259494  
## 3761 2.180090352 -0.05259494  
## 3762 2.658867413 0.02035227  
## 3763 1.736286460 0.23919392  
## 3764 1.383188377 -0.19848937  
## 3765 1.910030166 -0.05259494  
## 3766 2.146987407 -0.70911987  
## 3767 2.530383100 0.31214113  
## 3768 1.607241080 -0.12554216  
## 3769 2.475772591 -0.27143659  
## 3770 2.050857950 0.45803556  
## 3771 1.666527146 -0.12554216  
## 3772 1.695141556 0.23919392  
## 3773 2.563673067 -0.56322544  
## 3774 2.653256744 -0.56322544  
## 3775 1.560298485 0.82277163  
## 3776 1.877675310 -0.41733102  
## 3777 1.819885423 -0.34438380  
## 3778 2.207956673 -0.49027823  
## 3779 1.869633352 0.38508835  
## 3780 2.188880400 -0.12554216  
## 3781 1.959965118 0.74982442  
## 3782 2.159704923 -0.12554216  
## 3783 1.232822457 0.31214113  
## 3784 1.464169029 -0.56322544  
## 3785 2.040571724 -0.05259494  
## 3786 2.044873237 -0.27143659  
## 3787 2.485871795 0.53098278  
## 3788 1.887587492 -0.49027823  
## 3789 1.618462417 -0.70911987  
## 3790 2.021682473 -0.12554216  
## 3791 1.471836943 -0.70911987  
## 3792 1.961274274 0.02035227  
## 3793 2.032903810 -0.70911987  
## 3794 2.060957154 -0.49027823  
## 3795 1.968568143 0.02035227  
## 3796 1.950988048 0.16624670  
## 3797 1.639782958 -0.34438380  
## 3798 1.888896648 -0.34438380  
## 3799 1.469031608 0.60392999  
## 3800 2.250410733 0.45803556  
## 3801 2.689352046 0.31214113  
## 3802 2.130716468 -0.56322544  
## 3803 1.721511699 -0.41733102  
## 3804 2.148857630 0.67687721  
## 3805 2.170926260 0.38508835  
## 3806 2.667470438 -0.70911987  
## 3807 2.098735656 0.23919392  
## 3808 2.324284537 -0.12554216  
## 3809 2.097987567 0.09329949  
## 3810 2.449402449 0.53098278  
## 3811 1.820446490 0.02035227  
## 3812 1.598451032 -0.41733102  
## 3813 1.752557399 -0.41733102  
## 3814 1.750874198 0.02035227  
## 3815 1.391791403 0.23919392  
## 3816 1.887400469 0.89571885  
## 3817 2.329895206 -0.19848937  
## 3818 2.263689315 0.23919392  
## 3819 2.261258026 0.02035227  
## 3820 0.758159887 -0.49027823  
## 3821 1.842889165 -0.41733102  
## 3822 2.078163204 0.02035227  
## 3823 2.027667186 -0.49027823  
## 3824 1.770698561 0.31214113  
## 3825 1.724317033 -0.05259494  
## 3826 2.087701341 0.45803556  
## 3827 2.665787237 -0.12554216  
## 3828 1.477073567 -0.12554216  
## 3829 1.455004937 -0.12554216  
## 3830 1.956411694 0.38508835  
## 3831 1.734042192 -0.27143659  
## 3832 1.448646179 -0.70911987  
## 3833 1.561420619 0.31214113  
## 3834 2.457444407 0.16624670  
## 3835 2.866275131 0.31214113  
## 3836 1.955476583 0.16624670  
## 3837 1.665405012 -0.49027823  
## 3838 2.419291860 0.02035227  
## 3839 1.779488608 -0.05259494  
## 3840 2.098361612 -0.56322544  
## 3841 2.117250863 -0.27143659  
## 3842 1.587790762 0.16624670  
## 3843 2.048613683 -0.56322544  
## 3844 1.790709946 -0.34438380  
## 3845 1.938644577 -0.12554216  
## 3846 2.200101737 -0.19848937  
## 3847 2.242555797 -0.49027823  
## 3848 1.751996332 -0.34438380  
## 3849 2.450150538 0.16624670  
## 3850 2.423406350 0.02035227  
## 3851 1.694393467 0.02035227  
## 3852 1.726187256 -0.12554216  
## 3853 2.047117504 0.16624670  
## 3854 2.155777454 -0.27143659  
## 3855 1.207200403 -0.56322544  
## 3856 2.105281436 -0.12554216  
## 3857 1.709729295 0.02035227  
## 3858 2.061331198 -0.49027823  
## 3859 2.100231835 0.53098278  
## 3860 1.527756607 0.09329949  
## 3861 1.863648639 0.38508835  
## 3862 1.094051918 -0.05259494  
## 3863 2.136514159 -0.05259494  
## 3864 1.720015520 -0.56322544  
## 3865 2.103037169 0.02035227  
## 3866 1.653061541 0.09329949  
## 3867 2.064323555 0.23919392  
## 3868 2.355143215 0.45803556  
## 3869 2.344108900 -0.70911987  
## 3870 2.249849666 -0.12554216  
## 3871 1.787904611 0.38508835  
## 3872 2.018316072 -0.34438380  
## 3873 2.174479683 -0.19848937  
## 3874 1.956037650 0.09329949  
## 3875 2.208517740 0.02035227  
## 3876 1.864957795 -0.41733102  
## 3877 1.642962337 -0.19848937  
## 3878 1.650443229 0.09329949  
## 3879 1.774064962 0.31214113  
## 3880 1.698694979 0.31214113  
## 3881 1.659420299 -0.34438380  
## 3882 2.027480164 0.09329949  
## 3883 2.165315591 -0.27143659  
## 3884 2.011770292 0.23919392  
## 3885 1.783790121 -0.49027823  
## 3886 2.066754845 -0.19848937  
## 3887 2.325219649 -0.34438380  
## 3888 1.695889645 -0.12554216  
## 3889 2.175788839 -0.05259494  
## 3890 1.418348568 -0.49027823  
## 3891 2.253964156 -0.70911987  
## 3892 1.802679372 0.02035227  
## 3893 1.750500154 -0.12554216  
## 3894 1.894320294 -0.70911987  
## 3895 1.509615445 0.31214113  
## 3896 1.677935505 -0.41733102  
## 3897 1.877488288 0.02035227  
## 3898 1.553565683 0.38508835  
## 3899 2.068999112 0.31214113  
## 3900 1.744515440 -0.05259494  
## 3901 1.902736297 0.02035227  
## 3902 1.957907872 -0.70911987  
## 3903 2.359070683 -0.70911987  
## 3904 1.557306129 -0.05259494  
## 3905 1.697385823 -0.05259494  
## 3906 1.889831759 -0.27143659  
## 3907 1.768454293 -0.56322544  
## 3908 2.133895847 0.16624670  
## 3909 2.337937164 -0.12554216  
## 3910 1.849060900 0.23919392  
## 3911 1.720015520 0.31214113  
## 3912 1.439108042 -0.34438380  
## 3913 1.292856612 0.31214113  
## 3914 1.840270852 -0.12554216  
## 3915 1.972682633 0.23919392  
## 3916 2.042815992 -0.12554216  
## 3917 1.876366154 0.02035227  
## 3918 1.568714488 0.31214113  
## 3919 1.387115846 -0.70911987  
## 3920 1.431814173 0.31214113  
## 3921 2.275471720 -0.12554216  
## 3922 1.846629610 -0.49027823  
## 3923 1.499142197 -0.49027823  
## 3924 1.841392986 -0.34438380  
## 3925 2.512803005 -0.05259494  
## 3926 2.319234935 -0.12554216  
## 3927 1.662973722 -0.41733102  
## 3928 1.878797444 0.02035227  
## 3929 2.184765909 0.74982442  
## 3930 2.097987567 -0.19848937  
## 3931 1.917511058 0.45803556  
## 3932 2.381513358 -0.19848937  
## 3933 2.174666706 0.23919392  
## 3934 1.872251664 -0.12554216  
## 3935 1.506810111 0.67687721  
## 3936 1.878984466 0.23919392  
## 3937 2.143621006 -0.27143659  
## 3938 1.469592675 -0.41733102  
## 3939 1.625756287 0.31214113  
## 3940 2.467169566 -0.27143659  
## 3941 1.881602778 0.02035227  
## 3942 1.655492831 -0.78206709  
## 3943 2.382074425 -0.27143659  
## 3944 1.985213127 0.31214113  
## 3945 2.349719568 0.38508835  
## 3946 1.109761790 -0.19848937  
## 3947 1.447711067 -0.70911987  
## 3948 1.994938286 0.02035227  
## 3949 1.896377539 -0.49027823  
## 3950 2.477642814 -0.41733102  
## 3951 1.861591393 0.02035227  
## 3952 1.600134233 -0.34438380  
## 3953 1.721511699 0.09329949  
## 3954 1.734229214 -0.05259494  
## 3955 1.548890126 0.23919392  
## 3956 1.984652060 -0.34438380  
## 3957 2.307452531 -0.19848937  
## 3958 1.813152621 -0.05259494  
## 3959 1.989888684 -0.05259494  
## 3960 1.700378180 -0.19848937  
## 3961 1.450142357 0.09329949  
## 3962 2.050483906 0.53098278  
## 3963 2.595092812 0.67687721  
## 3964 2.045060259 0.67687721  
## 3965 1.745076507 0.60392999  
## 3966 1.976984146 -0.05259494  
## 3967 1.568153422 0.45803556  
## 3968 2.253216067 0.09329949  
## 3969 1.750687176 0.23919392  
## 3970 2.172609461 -0.19848937  
## 3971 1.949678892 0.67687721  
## 3972 2.731245039 0.02035227  
## 3973 1.665592034 0.16624670  
## 3974 2.556753243 -0.12554216  
## 3975 1.769202383 0.16624670  
## 3976 2.247231354 0.23919392  
## 3977 2.131090512 0.09329949  
## 3978 2.485871795 -0.05259494  
## 3979 2.680936043 -0.70911987  
## 3980 2.098548634 -0.05259494  
## 3981 2.077602138 0.09329949  
## 3982 2.080407472 -0.19848937  
## 3983 2.182521642 0.16624670  
## 3984 2.527764788 -0.19848937  
## 3985 2.129033267 -0.12554216  
## 3986 1.674569104 -0.34438380  
## 3987 2.166437725 -0.27143659  
## 3988 2.210200941 0.09329949  
## 3989 1.705240760 -0.63617266  
## 3990 2.044686215 0.23919392  
## 3991 2.389368294 0.82277163  
## 3992 1.702061381 -0.05259494  
## 3993 1.897125628 0.60392999  
## 3994 1.761347446 0.38508835  
## 3995 2.500833578 0.53098278  
## 3996 1.570958756 -0.05259494  
## 3997 1.872625709 -0.41733102  
## 3998 1.774251984 0.09329949  
## 3999 1.872064642 -0.41733102  
## 4000 1.720389565 -0.12554216

summary(trucks2)

## Distance Speeding   
## Min. :-1.1319 Min. :-0.7821   
## 1st Qu.:-0.5759 1st Qu.:-0.4903   
## Median :-0.4248 Median :-0.3444   
## Mean : 0.0000 Mean : 0.0000   
## 3rd Qu.:-0.1947 3rd Qu.:-0.1255   
## Max. : 3.1560 Max. : 6.5127

# Task3

## k-Means clustering

set.seed(1234)  
clusters1 <- kmeans(trucks2, 2)

## Visualize the clustering

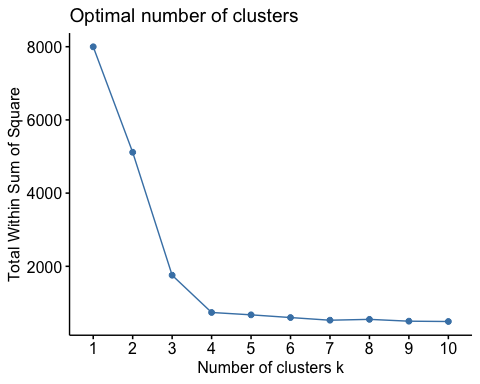
fviz\_cluster(clusters1, trucks2)

 ##The clusters are very similar to the first Cluster plot in that they show clustering of speeding and clustering of distance, but the two variables are only somewhat in the same range as the plot reaches (1, 3.5).

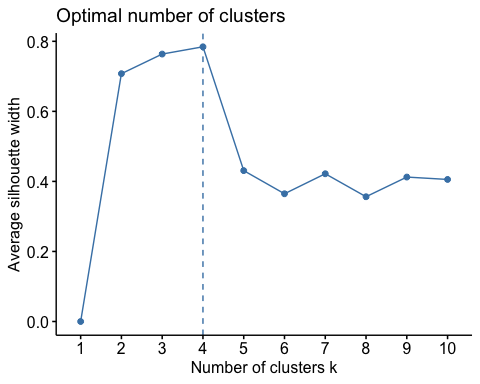
# Task4

## Visually identify optimal number of clusters

set.seed(123)  
fviz\_nbclust(trucks2, kmeans, method = "wss")



set.seed(123)  
fviz\_nbclust(trucks2, kmeans, method = "silhouette")



# Task5

set.seed(1234)  
clusters2 <- kmeans(trucks2, 4)  
clusters2

## K-means clustering with 4 clusters of sizes 695, 2774, 104, 427  
##   
## Cluster means:  
## Distance Speeding  
## 1 1.9523882 -0.01396965  
## 2 -0.4867234 -0.40244705  
## 3 1.9037667 4.34528041  
## 4 -0.4794634 1.57889429  
##   
## Clustering vector:  
## [1] 4 4 4 4 4 2 4 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 2 4 4 4 4 2 4 4 4 4 4 4  
## [35] 4 4 4 4 4 4 4 2 4 4 4 2 4 4 4 4 4 4 4 4 4 4 4 4 2 4 4 4 4 4 4 4 4 4  
## [69] 4 4 4 2 4 4 4 4 4 4 4 4 4 2 4 2 4 2 4 4 4 4 4 2 4 4 4 4 4 4 4 4 4 4  
## [103] 2 4 4 4 4 4 4 4 4 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 2 4 4  
## [137] 4 4 2 4 4 4 4 4 2 4 2 4 4 4 4 4 4 4 4 4 4 2 4 4 4 4 4 4 2 4 4 4 4 4  
## [171] 4 4 4 4 4 4 4 4 4 4 2 4 4 4 4 4 4 4 2 4 2 4 4 4 4 4 4 4 4 4 4 4 4 4  
## [205] 4 4 4 4 4 4 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4  
## [239] 4 4 4 4 4 4 4 4 4 4 4 2 4 4 4 2 4 4 4 4 4 4 4 4 4 2 4 4 4 4 4 4 4 4  
## [273] 4 4 4 4 2 4 4 4 4 4 4 2 4 4 2 4 4 4 4 4 4 4 4 2 4 4 4 4 4 4 4 4 4 4  
## [307] 4 4 4 4 4 4 4 4 4 4 4 2 4 4 4 4 4 4 4 2 4 4 4 4 4 4 4 4 4 4 4 2 4 4  
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## [375] 4 4 4 4 4 4 4 4 4 4 4 4 4 2 4 4 4 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4  
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## [749] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [1123] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [1259] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1293] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [1395] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1429] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1463] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1497] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [1599] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [1735] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
## [1769] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [2007] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
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## [3197] 2 2 2 2 3 3 3 3 3 3 1 3 3 3 3 3 3 1 3 1 3 3 3 3 1 3 3 3 3 3 3 3 3 3  
## [3231] 3 3 3 3 3 3 3 3 3 3 3 1 3 3 3 3 3 1 3 1 3 3 3 3 3 3 3 3 3 3 3 1 3 3  
## [3265] 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 3 1 3 3 3 3 3 3 3 1 3 3 3 1 3 3 1 3 3  
## [3299] 3 3 1 3 3 3 3 3 3 3 3 3 3 3 3 1 1 3 3 3 3 3 1 1 1 1 1 1 1 1 1 1 1 1  
## [3333] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3367] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
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## [3469] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
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## [3537] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3571] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3605] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
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## [3673] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
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## [3911] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3945] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [3979] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
##   
## Within cluster sum of squares by cluster:  
## [1] 206.0752 181.9107 165.5278 185.4551  
## (between\_SS / total\_SS = 90.8 %)  
##   
## Available components:  
##   
## [1] "cluster" "centers" "totss" "withinss"   
## [5] "tot.withinss" "betweenss" "size" "iter"   
## [9] "ifault"

fviz\_cluster(clusters2, trucks2)



# Task6

## The clusters display significant relationships when using the optimal number of clusters.

# Wine Data

# Read in data

wine = read\_csv("wineprice.csv")

## Parsed with column specification:  
## cols(  
## Year = col\_double(),  
## Price = col\_double(),  
## WinterRain = col\_double(),  
## AGST = col\_double(),  
## HarvestRain = col\_double(),  
## Age = col\_double(),  
## FrancePop = col\_double()  
## )

str(wine)

## Classes 'spec\_tbl\_df', 'tbl\_df', 'tbl' and 'data.frame': 25 obs. of 7 variables:  
## $ Year : num 1952 1953 1955 1957 1958 ...  
## $ Price : num 7.5 8.04 7.69 6.98 6.78 ...  
## $ WinterRain : num 600 690 502 420 582 485 763 830 697 608 ...  
## $ AGST : num 17.1 16.7 17.1 16.1 16.4 ...  
## $ HarvestRain: num 160 80 130 110 187 187 290 38 52 155 ...  
## $ Age : num 31 30 28 26 25 24 23 22 21 20 ...  
## $ FrancePop : num 43184 43495 44218 45152 45654 ...  
## - attr(\*, "spec")=  
## .. cols(  
## .. Year = col\_double(),  
## .. Price = col\_double(),  
## .. WinterRain = col\_double(),  
## .. AGST = col\_double(),  
## .. HarvestRain = col\_double(),  
## .. Age = col\_double(),  
## .. FrancePop = col\_double()  
## .. )

summary(wine)

## Year Price WinterRain AGST   
## Min. :1952 Min. :6.205 Min. :376.0 Min. :14.98   
## 1st Qu.:1960 1st Qu.:6.519 1st Qu.:536.0 1st Qu.:16.20   
## Median :1966 Median :7.121 Median :600.0 Median :16.53   
## Mean :1966 Mean :7.067 Mean :605.3 Mean :16.51   
## 3rd Qu.:1972 3rd Qu.:7.495 3rd Qu.:697.0 3rd Qu.:17.07   
## Max. :1978 Max. :8.494 Max. :830.0 Max. :17.65   
## HarvestRain Age FrancePop   
## Min. : 38.0 Min. : 5.0 Min. :43184   
## 1st Qu.: 89.0 1st Qu.:11.0 1st Qu.:46584   
## Median :130.0 Median :17.0 Median :50255   
## Mean :148.6 Mean :17.2 Mean :49694   
## 3rd Qu.:187.0 3rd Qu.:23.0 3rd Qu.:52894   
## Max. :292.0 Max. :31.0 Max. :54602

## Delete rows with missingness

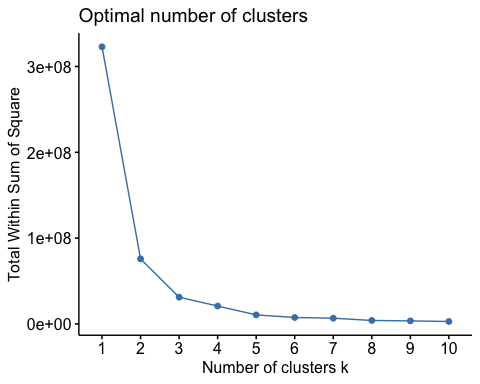
wine2 = wine %>% drop\_na(Year, FrancePop)  
summary(wine2)

## Year Price WinterRain AGST   
## Min. :1952 Min. :6.205 Min. :376.0 Min. :14.98   
## 1st Qu.:1960 1st Qu.:6.519 1st Qu.:536.0 1st Qu.:16.20   
## Median :1966 Median :7.121 Median :600.0 Median :16.53   
## Mean :1966 Mean :7.067 Mean :605.3 Mean :16.51   
## 3rd Qu.:1972 3rd Qu.:7.495 3rd Qu.:697.0 3rd Qu.:17.07   
## Max. :1978 Max. :8.494 Max. :830.0 Max. :17.65   
## HarvestRain Age FrancePop   
## Min. : 38.0 Min. : 5.0 Min. :43184   
## 1st Qu.: 89.0 1st Qu.:11.0 1st Qu.:46584   
## Median :130.0 Median :17.0 Median :50255   
## Mean :148.6 Mean :17.2 Mean :49694   
## 3rd Qu.:187.0 3rd Qu.:23.0 3rd Qu.:52894   
## Max. :292.0 Max. :31.0 Max. :54602

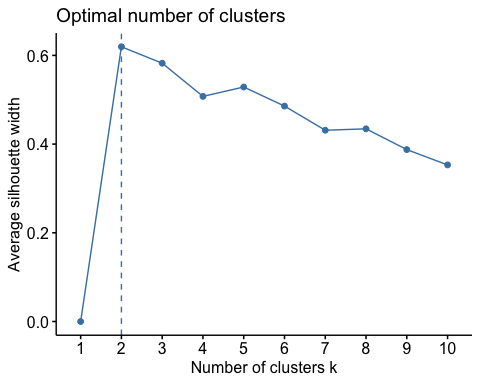
# Task7

## Visually identify optimal number of clusters

set.seed(123)  
fviz\_nbclust(wine2, kmeans, method = "wss")



set.seed(123)  
fviz\_nbclust(wine2, kmeans, method = "silhouette")

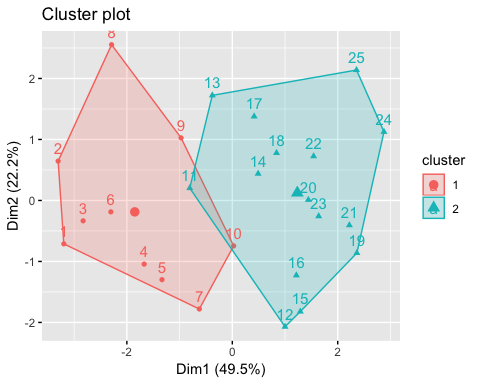
 ##Both methods display the optimal number of clusters is 2.

# Task8

set.seed(1234)  
clusters3 <- kmeans(wine2, 2)  
clusters3

## K-means clustering with 2 clusters of sizes 10, 15  
##   
## Cluster means:  
## Year Price WinterRain AGST HarvestRain Age FrancePop  
## 1 1958 7.417070 617.7 16.68000 138.9 25 45843.08  
## 2 1971 6.833993 597.0 16.39556 155.0 12 52262.01  
##   
## Clustering vector:  
## [1] 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2  
##   
## Within cluster sum of squares by cluster:  
## [1] 32002378 43752491  
## (between\_SS / total\_SS = 76.5 %)  
##   
## Available components:  
##   
## [1] "cluster" "centers" "totss" "withinss"   
## [5] "tot.withinss" "betweenss" "size" "iter"   
## [9] "ifault"

fviz\_cluster(clusters3, wine2)



# Task9

## Agglomerative clustering

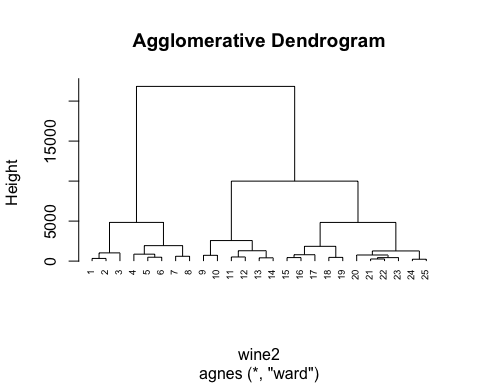
Start by identifying best dissimilarity measure. This is given by highest “agglomerative coefficient”.

m = c( "average", "single", "complete", "ward")  
names(m) = c( "average", "single", "complete", "ward")  
  
ac = function(x) {  
 agnes(wine2, method = x)$ac  
}  
map\_dbl(m, ac)

## average single complete ward   
## 0.9256430 0.5381098 0.9542118 0.9764666

## Plot the dendogram. Ward’s is highest. Use this to develop clusters.

hc = agnes(wine2, method = "ward") #change ward to other method if desired  
pltree(hc, cex = 0.6, hang = -1, main = "Agglomerative Dendrogram")



# Task10

## Divisive clustering

hc2 = diana(wine2)  
pltree(hc2, cex = 0.6, hang = -1, main = "Divisive Dendogram")

